PATENT SPECIFICATION

671,085

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COMPLETE SPECIFICATION

Improvements in Plants for Drying and/or Storing Grain and other Agricultural Products

I, ERIK JOHAN VON HEIDENSTAM, of 58, Regeringsgatan, Stockholm, Sweden, a subject of the King of Sweden, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement :—

It has always been of great importance to be able to dry and store grain and other agricultural products in a technically satisfactory and inexpensive manner, so that the storage losses will be as low as possible and the operating costs for the necessary plant will also be kept at a minimum.

The problems arising in this connection vary considerably in different cases. For instance, there are the problems of large industrial plants and the problems of individual farms.

A consideration of the questions connected for instance with the treatment of grain discloses that the increased use of harvesting-threshing in particular has caused great changes in the conditions, because the grain must be rationally treated within the space of a few weeks, while in industrial plants drying and storing may often advantageously be dealt with as two completely different problems, drying being effected by means of dryers with great capacity and often operating with relatively high temperatures to such a degree that the grain may be stored in closed silos for a very long time. In individual farms, however, the storing requirements are so relatively small that it is economically impossible to use, for instance, drying equipment of a technical quality equal to that used for industrial storage, by way of example in mills. The present invention renders it possible to store, for instance, grain in a rational manner with a special view to individual farms.

According to the invention a plant for drying and/or storing agricultural products, by way of example grain, and comprising a number of storage units (bins), is characterised in that the storage bins are placed adjacent each other, when seen in plan, around a vertical, central axis (located at the centre of the plant) and are constructed so as to be discharged into and be filled from a vertical conveyor which preferably is located centrally within the plant, while each bin is provided with a perforated bottom and each bin is so low that a uniform air-current may be passed through said perforated bottom and the grain by means of a ventilator or fan.

The advantages obtained by the invention are numerous. For instance, the building required will be very concentrated and the consumption of materials a minimum. The wall and roof surface of the plant may be designed in a manner particularly favourable in respect of carrying capacity. The walls of the storage units will be a minimum, because to a certain degree they may be common for adjacent units. In addition to the building work, the installation work in the strongly concentrated plant according to the invention will represent a minimum—as horizontal conveyors with mechanical or pneumatic equipment may be completely omitted—and the costs for this work as well as the annual costs (interests, amortisation and maintenance, running costs etc.) of the complete plant will be considerably lower than for plants for drying and storing used hitherto. The building details may be highly standardised. The assemblage may be carried out particularly rapidly by a small number of workmen, and the plant as a unit is easily adapted for large scale production.

Air channels—whether they are intended for ventilation or for pneumatic conveyance—will be short and easily constructed in an effective manner. This includes the construction of air-penetrable bottoms in the storage units. Protected charging and dis-

[*Price* 2*s*. 8*d*.]

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charging of the plant may easily be arranged, and may furthermore be combined with loading and unloading magazines (bins or the like).

Various embodiments of the invention will be described in detail in the following text, reference being had to the accompanying drawings in which :—

Figures 1 and 2 are vertical sections through a plant according to the invention,

Figure 3 is a horizontal section along the line III–III in Figure 1.

Figure 4 is a horizontal section along the line IV–IV in Figure 2.

Figure 5 is a cross-section through an air supply channel.

Figure 5*a* is a detail showing a pneumatic conveying tube with grain injector.

Figures 6, 7, 8 and 10 are vertical sections through different plants.

Figure 9 is a plan along the line IX–IX in Figure 8.

Figure 11 is a top plan view of a plant with storage units spaced from each other, and

Figure 12 is a top plan view of a plant divided into four storage units.

In Figure 1, the numeral 1 designates grain stored in a storage unit (bin) 2. Such storage units 2 are formed between an enclosing outer wall 3 and partitions 4. The grain rests on an air-penetrable bottom 5 carried by beams 6 which rest against a thin concrete plate 7, the latter lying on the ground or on filling 8. 9 designates a dome-shaped roof over the plant and 10 is a cage at the top of the roof. 11 is a platform which is accessible via a flight of steps 12. 13 is a lorry and 13*a* a loading room. 14 is a loading pocket, 15 a precleaner, 16 a tipping chute, 17 a supply funnel, 18 a pneumatic conveyor tube with inlet chamber 19. 20 is a fan driven by a motor 21. 22 is a diffuser, 23 a heating battery, 24 a distribution drum, 25 a discharge pocket and 26 a channel feeding air to the pneumatic conveyor.

Figure 2 is another vertical section through the plant shown in Figure 1. 27 is an air distribution channel beneath the storage unit 2. 28 are steps leading to the engine room 29. In this case the line 30 designates a contour line (compare Figure 5) and not a concrete plate (7) as in Figure 1. 31 is the inner wall of the storage unit, 32 is a ground plate under the outer walls of the plant.

Figure 5 is a cross-section on the line V–V in Figure 2, with the air distribution channel 27 enveloped by concrete walls 33.

Figure 5*a* shows a detail of the inlet chamber 19 of the pneumatic conveying tube 18. The air is led to the inlet chamber through the feed channel 26. The pneumatic conveying tube has a constricted section (at 34) at the bottom, and thus at said place it will act as an injector for grain supplied via a feed tube 17*a* (which can replace the supply funnel 17 shown in Figure 1).

The plant according to Figures 1 to 5*a* functions in the following manner :

The lorry 13 backs into the loading room 13*a*, where it empties its load—for instance consisting of harvesting-threshed grain coming directly from the field—into the loading pocket 14, from which the grain passes the pre-cleaner 15, the tipping chute 16, the supply funnel 17 and via an injecting device enters the vertical, centrally placed pneumatic conveying tube 18, the grain being conveyed up through the latter and discharged into the desired storage unit 2. For this purpose the conveying tube has a rotatable top portion so that—viewed from above—it can be adjusted to an arbitrary outlet direction. The storage unit 2 is filled with grain until the level of the same, for instance, assumes the position shown in the Figure 1.

The motor 21 drives the fan 20 which, via the diffuser 22, is connected with the heating battery 23 from which preheated air may be distributed to each one of the radially placed distribution channels 27 via the distribution drum 24, each of said distribution channels 27 being located exactly under its storage unit. From the distribution channel 27 the conditioning air passes in between the beams 6 (see Figure 5) and from there further on through the air-penetrable bottom 5, and thus into the grain and flows through the same in the direction of the arrows in Figure 1. While flowing through the grain the conditioning air acts upon the grain in different ways. During the time immediately after the grain has been stored, an effort is made to attain the quickest possible reduction of the moisture of the grain, which by way of example can amount to 25% under unfavourable harvesting conditions and perhaps to 20% under favourable conditions. At normal temperatures, however, the grain cannot be stored—at least not without suffering damage—unless the content of water is reduced to considerably below 20%. If possible, it is desired to reduce it to 14–16% for storing of long duration. Thus, immediately after the grain has been placed in the plant, it is very important that preheated air having the smallest possible content of water be blown through the grain in an effective manner, as allowed in the plant according to this invention. In certain cases the preheating of the admitted outer air may be omitted. Particularly in later stages of the storing it is sufficient only to blow untreated air through the stored grain and—in order that the air shall contain the least possible moisture—such airing is effected during the night, when the temperature is

low and the moisture of the air has been precipitated in the form of dew. When such relatively very cold air having a low content of water is supplied to the grain, the air will be heated by the grain, and thereby the relative moisture of the air will fall considerably, and thus the water-absorbing capacity of the air will increase essentially, and the air will be able to dry the grain. The air leaving the plant, which air is mixed with moisture and heated by the grain, is removed via the cage 10 at the top of the dome-shaped roof 9.

It is shown in Figure 1 how the air is conducted to the pneumatic conveyor 18 via the feed channel 26 and the inlet chamber 19, the feed channel 26 initiating at the pressure side but before the heating battery. Of course the feed channel 26 may also initiate for instance from the distributing drum 24, in which case the pneumatic conveyance may be effected by hot air and thus an increased drying effect be obtained during the process of the vertical conveyance. Valves, which are presumed to be provided for shutting off the pneumatic conveyance (valves in the feed channel 26) and for shutting off the feed from the air distributing drum 24 to the respective air distribution channels 27, are not shown in Figure 1. The operation of these valves is presumed to be carried out in such a manner that either the pneumatic conveyance or the system for airing the storage units is in operation. Normally, these two systems accordingly are not presumed to function simultaneously.

The beams 6 under the air-penetrable bottom may also be arranged in other ways than that described above. By way of example, they may be arranged substantially radially and be fed either from intake apertures facing the engine room or from a distribution channel of a type similar to the distribution channels 27 but arranged annularly, for instance close to the circumference of the building.

For the attendance of the equipment provided, access is gained to the engine room by means of the steps 28 from the loading room 13a. In order to avoid that the air taken in through the fan is mixed with air leaving the storage units, there is presumed the provision of an intake drum (not shown), extending from the surrounding air preferably through the loading room and on to the fan.

Thus, it has been described above how the grain is received and how it is conveyed within the plant and stored in different storage units under simultaneous treatment with conditioned air. What finally remains is the removal of the grain from the plant, which is effected in such a manner that the discharge pocket 25 is filled from the vertical conveyor 18, and from the pocket 25 the grain may run down either for being placed loose on a lorry 13 or for being placed in sacks for immediate or later transport by lorry.

Because of the extraordinary concentration of the plant shown, it is economically possible to combine installations for the treatment of the grain with conditioning air with the installation for pneumatical vertical conveyance. This results in exceptionally low installation costs.

Furthermore, the concentrated form of the plant involves low costs for building works, and this is specially so because the enveloping walls 3 and the roof 9 both constitute parts of one and the same dome with the essential saving of material allowed thereby.

The running costs of the plant are low since the same is particularly easy to maintain. By way of example, the sloping bottoms of the storage units present the advantage that the major part of the grain stored in a storage unit runs out by itself to the vertical conveyor, and the remaining part of the contents of the storage unit is easily conveyed to the outlet by hand. A good oversight of the stock at any moment is obtained from the platform 11. Figure 1 shows how the height of the layer of stored grain may decrease toward the outer wall in order to ensure an increased penetration of air through the grain nearest to the outer wall, where under certain conditions it will be possible in this way to reduce the risk of condensation. The significance of such a lower height of the layer adjacent the outer wall is also of advantage should the outer wall—for instance in heavy rain—appear to be water-penetrable to some degree.

Figure 6 shows another embodiment according to the invention of a plant for drying and storing agricultural products, in which the majority of the storage units are placed in an outer circuit (adjacent the loading room 13*a*) and one storage unit 2*a* is placed centrally and in an elevated position relatively to the others. As far as the outer units are concerned, the supply of air to the different storage units is effected by means of air distribution channels 27 (not shown) in the same manner as described above in connection with Figures 2 and 4, while the centrally located storage unit is supplied with air via the air-penetrable bottom 5. In this case the engine room 29 must be tightly closed and accordingly has to be provided with a door leading to the steps 28.

Also in this case the vertical conveyor tube is presumed to be rotatable—at least at the top portion thereof—to allow discharge to any storage unit desired. Preferably, the tube may be journalled upwards for

instance in relation to the cage 10. For discharge into the centrally located bin the valve 18*a* is adjusted.

Figure 7 is a vertical section through a plant, in which the vertical conveyor 18 is formed by an elevator, from which grain is discharged via a chute 35 to the storage unit 2, the bottom of which has a steep slope. Discharge of the bins is effected by means of conveyor belts 36, feeding the elevator, the lower part of which is sunk within an elevator pit 37. The enveloping walls 3 together form a conical surface. The roof 9 consists of a dome-shaped surface having an additional piece 9*a* built out to accommodate the top part of the elevator. Charging from the lorry 13 takes place via an opening 14*a* covered by a shutter 14*b*.

The walls 4 between adjacent storage units continue under the bottoms 5 in the form of walls 4*a*, which transfer the weight of the grain etc. to the ground. By means of walls 31*a* the spaces 27*a* under the air-penetrable bottoms are separated from the engine room 29, to which conditioning air is presumed to be supplied, the air being allowed to flow into the respective spaces 27*a* via shutters in the walls 31*a*.

It is presumed that the conveyor 36 may be moved from one space 27*a* to another.

In the present case it is also possible to effect the unloading of a storage unit by means of a pneumatic conveyor tube installed in the form of a circle as indicated by the reference numeral 38, which conveyor tube may continue in a pipe conduit, discharging centrally at the roof of the plant.

According to Figure 8 the plant is built with a story lying beneath the storage units 2, said story containing the central engine room 29, rooms 27*a* and loading room 13*a*. The discharge from the centrally placed, vertical conveyor 18, in this case consisting of an elevator, takes place via a tipping chute 16*a*, which at the discharge to the central storage unit 2*a* acts as a short tipping chute 16*b* if a valve is provided in the bottom of the same.

In Figure 9 the storage units are shown as constructed in the form of regular 6-cornered cells with common separating walls.

Figure 10 shows a plant in which the bottom 5 slopes so steeply that the storage units are emptied completely by self-precipitation alone into the vertical conveyor 18 equipped with injector. The charging from the vehicle 13 is effected via the conveyor 36. The distribution of air to the different rooms 27*a* is effected via a distributing drum (not shown) provided with valves.

Figure 11 shows a plant having a number of circular-cylindrical storage units in the form of small silos, placed around the central vertical conveyor 18 and arranged for self-emptying to the same in the manner shown by the arrows. The dash line 39 drawn indicates a possible central storage unit, placed in an elevated position.

Figure 12 shows a plant having four storage units 2 with common partitions 4 directly connecting on to the vertical conveyor 18. In an independent plant the enveloping wall 3 preferably may be of cylindrical shape, while, if the plant is erected for instance within already existing buildings, the same may be rectangular etc. (in top plan view).

Further it must be pointed out that the plant may also be operated in such a manner that the ventilation air which leaves a bin and has a high content of moisture may be restored and caused to pass a cooling battery, in which the moisture is frozen to ice, and then the same air may be forced in through the perforated bottom again and through grain under storage. In such a case the outgoing air is thus returned, and when its content of water has been removed more or less, it is again capable of absorbing moisture from the grain and then be de-moistened again through freezing et cetera. In a plant of this type also, the advantage is obtained that the grain is kept cool all the time, which is also very significant. As a matter of fact, the essential factors acting favourably upon grain being stored are the following :

1. Low content of moisture,
2. Low temperature,
3. Other conditions suppressing the respiration of the grain.

Among the latter is for instance the theoretical possibility of shutting off the supply of oxygen, but this cannot be done unless simultaneously the content of moisture and the temperature do not exceed certain pre-determined values i.e. about 17% content of moisture and about 15° C.

The plant according to the invention may also be run in such a way that the conditioning air is dried, for instance by means of sulphuric acid or unslaked lime (possibly a combination of these means). Thus, the plant generally may be run in combination with means for de-moistening air to storage bins.

The loading pocket is preferably so constructed that it may be filled by self-precipitation from one or both of the adjoining storage units (or possibly from the discharge pocket). In this simple manner there is obtained the possibility that by a renewed operation of the vertical conveyor during the storing, the grain may be cleaned again by means of the pre-cleaner, in case it should be desirable to improve the storage conditions through a further removal of chaff or the like, this with a special view to

obtaining a uniform distribution of air. As mentioned above, the pre-cleaner is preferably mounted stationarily after the loading pocket.

Of course the plant may also be used for drying other agricultural products than grain.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is :—

1. A plant for drying and/or storing agricultural products, for instance grain, comprising a number of storage bins, characterised in that the storage bins are placed adjacent each other, when seen in plan, around a vertical, central axis (located at the centre of the plant) and are constructed so as to be discharged into and be filled from a vertical conveyor which preferably is located centrally within the plant, while each bin is provided with a perforated bottom and each bin is so low that a uniform air-current may be passed through said perforated bottom and the grain by means of a ventilator or fan.

2. A plant according to claim 1, characterised in that two adjacent storage bins have a common separating wall.

3. A plant according to claim 2, characterised in that the separating walls extend radially or substantially radially from the centre of the plant.

4. A plant according to claim 1, characterised in that between two storage bins a loading room (space) accessible to vehicles is arranged for loading grain etc. to the plant and/or unloading grain etc. from the same.

5. A plant according to claim 4, characterised in that in connection with (within) the loading room there is arranged a loading pocket discharging into the vertical conveyor and/or an unloading pocket having discharge from the vertical conveyor.

6. A plant according to claim 5, characterised in that the unloading pocket is arranged to be filled from the vertical conveyor.

7. A plant according to claim 1, characterised in that air is supplied to the storage bins from the spaces beneath the air-penetrable perforated bottom via one or more substantially radially directed air feeding channels.

8. A plant according to claim 7, characterised in that conditioning air is supplied via a fresh air inlet and a fan or the like as well as via a distributing channel which via a valve is connectable to a radially directed supply channel.

9. A plant according to claim 8, characterised in that from the pressure side of the fan or the like there extends an air-pipe provided with a control valve, said pipe leading to the vertical conveyor which consists of a pneumatic conveyor tube.

10. A plant according to claim 1, characterised in that the plant is covered completely or partly by a cupola roof.

11. A plant according to claim 10, characterised in that the outer limiting walls of the storage units and the roof surface form parts of one and the same spherical surface.

12. A plant according to claim 1, characterised in that the air-penetrable perforated bottom has a slope α relatively to the horizontal plane.

13. A plant according to claim 12, characterised in that the air-penetrable bottom slopes in direction inwards-downwards at an angle α, which is $<45°$, particularly $5° < \alpha < 25°$ and preferably $10° < \alpha < 20°$.

14. A plant according to claim 12, characterised in that the air-penetrable bottom slopes in direction outwards-downwards at an angle α, which is $<45°$, particularly $5° < \alpha < 25°$ and preferably $10° < \alpha < 20°$.

15. A plant according to claim 1, characterised in that the grain is unloaded by means of a horizontal or sloping horizontal conveyor (mechanical or pneumatic) which —in plan view—conveys the goods towards the centre axis of the plant.

16. A plant according to claim 15, characterised in that the horizontal conveyor is movable to different positions for successive unloading of different storage bins.

17. A plant according to claim 1, characterised in that the vertical conveyor is arranged within a space limited by the inner side walls of the storage bins.

18. A plant according to claim 1, characterised in that the discharge of a storage bin takes place by means of a pneumatic conveyor tube, the first portion of which extends horizontally and—in plan view—adjacent the lower, outer limiting line.

19. A plant according to claim 1, characterised in that after the conditioning air has passed a storage bin it circulates, passing the fan as well as a cooling battery or another device for the de-moistening and/or the cooling of the air, whereupon it is forced through the grain again.

20. A plant for drying and/or storing grain or other agricultural products constructed and arranged substantially as herein described with reference to and as illustrated in the accompanying drawings.

Dated this 6th day of December, 1949.

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Fig 1

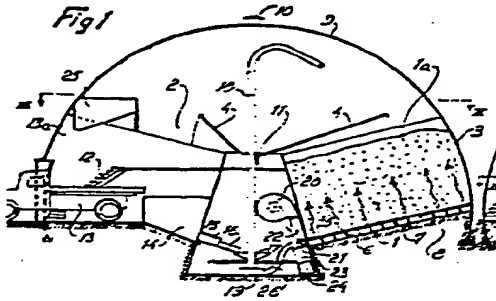


Fig 2

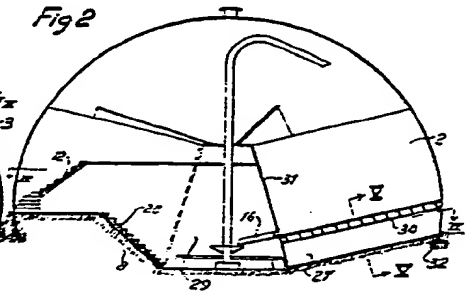


Fig 3

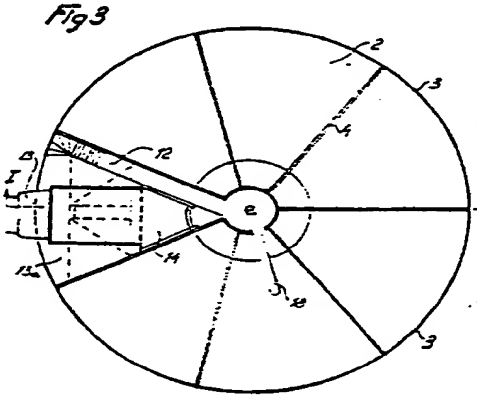


Fig 4

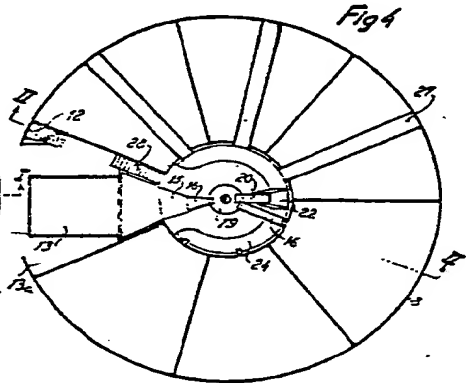


Fig 5

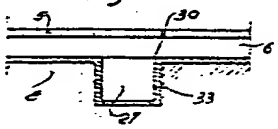


Fig 5a

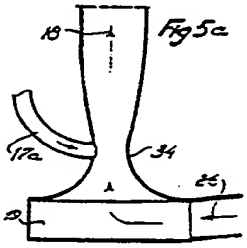


Fig 6

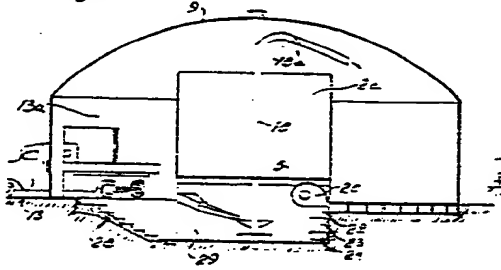
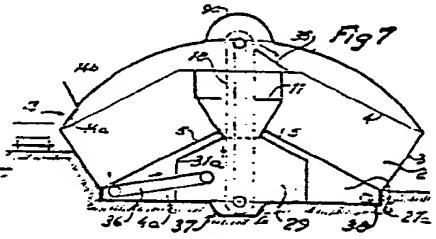


Fig 7



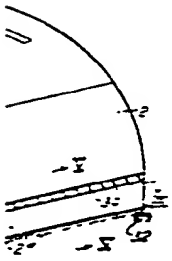
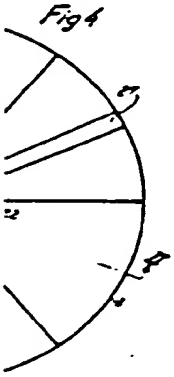


Fig 4



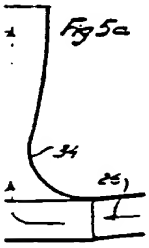


Fig 7

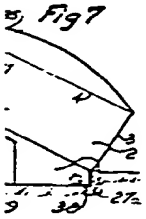


Fig 8

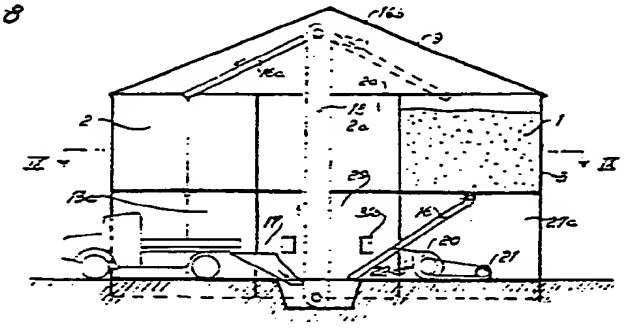


Fig 10

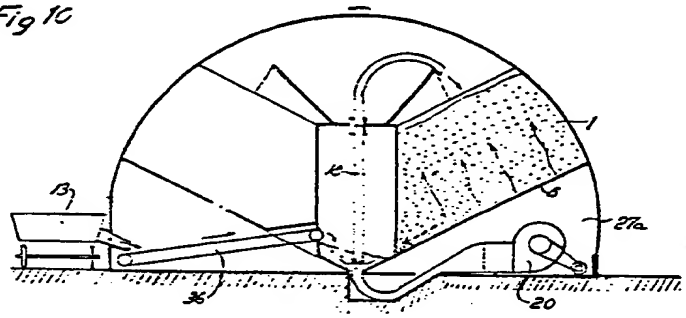
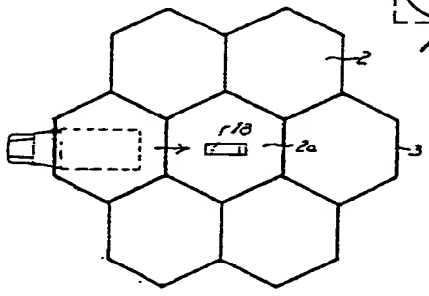


Fig 9



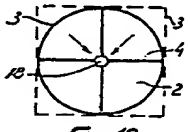
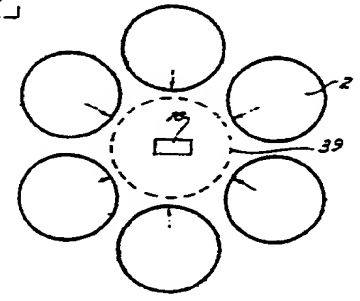


Fig 12

Fig 11



671,085 COMPLETE SPECIFICATION

2 SHEETS

SHEET 1

SHEET 2

Fig 1

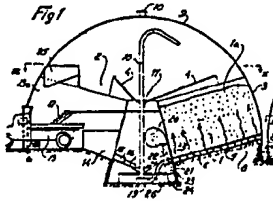


Fig 2

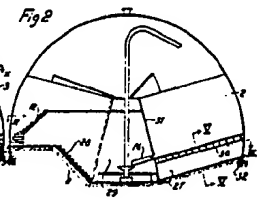


Fig 3

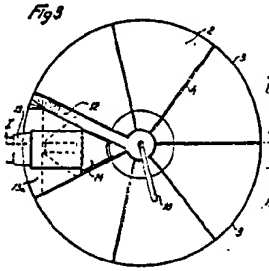


Fig 4

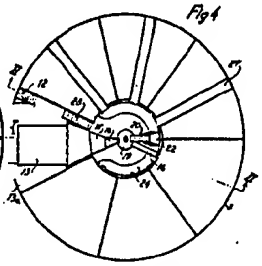


Fig 5

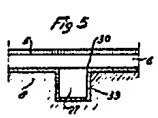


Fig 5a

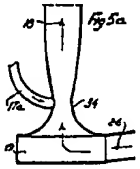


Fig 6

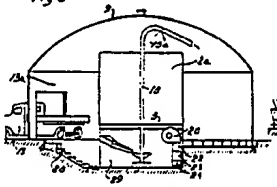


Fig 7

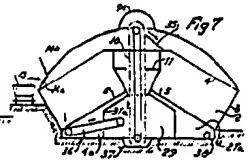


Fig 8

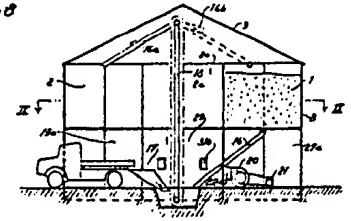


Fig 10

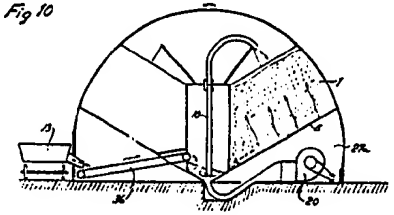


Fig 9

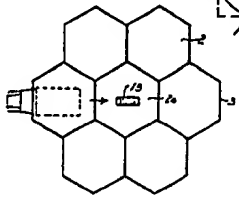


Fig 12

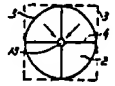
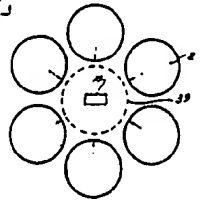


Fig 11



H.M.S.O. (M.F.P.)